

Application No. 10/692,267
Response to Office Action

Customer No. 01933

Listing of Claims:

1. (Currently Amended) A fixing device of an image forming apparatus for thermally fixing a toner image formed on a transfer material, the fixing device comprising:

(a) a heating roller having a heating device; and

5 (b) a temperature detector which is spaced away from the heating roller, ~~comprising and which comprises:~~ a surface temperature detecting sensor for detecting a temperature of a surface of the heating roller, a compensation temperature sensor for detecting an ambient temperature of the surface temperature
10 detecting sensor, and a casing having an opening portion ~~representing at~~ a first position and a portion enclosed by the casing ~~representing at~~ a second position,

wherein the surface temperature detecting sensor is placed at the first position ~~at which~~ such that heat radiation of the
15 heating roller is directly incident through the opening to the surface temperature detecting sensor, and the compensation temperature sensor is placed at the second position, ~~and~~

wherein the opening portion is disposed so as not to enter a region between a vertical plane containing a central axis of the
20 heating roller and a tangential plane to a circumferential surface of the heating roller parallel to the vertical plane, and wherein a central portion of the surface temperature detecting sensor faces the central axis of the heating roller.

Application No. 10/692,267
Response to Office Action

Customer No. 01933

2. (Original) The fixing device of claim 1, wherein the second position is a position at which the heat radiation of the heating roller is not directly incident.

3. The fixing device of claim 1, wherein, for each of the surface temperature detecting sensor and the compensation temperature detecting sensor, an angle made by each between (i) a
5 sensors the sensor perpendicularly to the central axis of the heating roller, which represents a shortest distance between the central position and the central axis, and (ii) a plane containing a sensor surface of the sensor corresponding one of the two sensors, is 90 degrees \pm 5 degrees.

4. (Currently Amended) The fixing device of claim 1, wherein the casing for accommodating the two sensors of the temperature detecting device and a mounting member to be attached to the casing, ~~is~~ are made of a material having a good thermal conductivity.

5. (Currently Amended) The fixing device of claim 1, wherein, except for an area exposed by the opening portion, the two sensors are ~~fitted so as to be~~ covered by the casing ~~excluding the opening portion.~~

Application No. 10/692,267
Response to Office Action

Customer No. 01933

6. (Original) An image forming apparatus comprising:

(a) the fixing device set forth in claim 1;

(b) a calculating device for calculating the surface
temperature of the heating roller on the basis of outputs of the
two sensors; and

(c) a controller for controlling a temperature of the fixing
device according to the calculated surface temperature.

7. (Currently Amended) An image forming apparatus
comprising:

(a) a fixing roller having a heater therein for fixing a
toner image ~~formed on the basis of image information~~ to a
recording material;

(b) a temperature detector spaced apart from the fixing
roller for detecting a temperature of the fixing roller and
outputting a detected value of the temperature; and

(c) a temperature controller for controlling the heater to
control the temperature of the fixing roller ~~by making the heater~~
~~to operate so as to make the fixing roller come to be at a preset~~
temperature, based ~~on the basis of~~ a preset reference temperature
and the detected ~~value of the~~ temperature,

wherein during a still state of the fixing roller the
temperature controller controls the temperature of the fixing
roller based on a first value for ~~with the reference~~

Application No. 10/692,267
Response to Office Action

Customer No. 01933

temperature, and based on a second value for the reference
temperature during ~~a~~ rotation of the fixing roller, ~~made to have~~
~~a temperature~~ said second value being obtained by the ~~addition of~~
20 adding a preset correction value α to ~~a set temperature~~ the first
~~value of the fixing roller.~~

8. (Currently Amended) The image forming apparatus of
claim 7, wherein ~~the temperature controller controls the~~
~~temperature of the fixing roller,~~ when the fixing roller is
rotating rotated at a rotation speed slower than that of the
5 ~~fixing roller at the time the reference temperature is made to~~
~~have the temperature value obtained by the addition of the~~
~~correction value α to the set temperature value of the fixing~~
~~roller, with a rotation speed thereof during said rotation~~
corresponding to the second value, the temperature controller
10 controls the temperature of the fixing roller based on a third
value for the reference temperature ~~made to have a value~~ obtained
by ~~the addition of~~ adding a preset correction value β which is
smaller than the correction value α to the ~~set temperature~~ first
~~value of the fixing roller.~~

9. (Original) An image forming apparatus comprising:
(a) a heating roller heated by a heating element;

Application No. 10/692,267
Response to Office Action

Customer No. 01933

(b) a roller heat detecting sensor for detecting heat radiated from the heating roller;

5 (c) an ambient temperature detecting sensor for detecting an ambient temperature of the roller heat detecting sensor;

(d) a surface temperature calculator for calculating surface temperature information of the heating roller; and

10 (e) a heating controller for controlling the heating of the heating roller on the basis of the surface temperature information calculated by the surface temperature calculator,

wherein the surface temperature calculator calculates the surface temperature information of the heating roller by making the detection information of the roller heat detecting sensor and
15 the detection information of the ambient temperature detecting sensor to be in association with data table information in which the surface temperature information of the heating roller corresponds to the detection information of the roller heat detecting sensor and the detection information of the ambient
20 temperature detecting sensor is written, and calculates an average value of the plural values of the surface temperature information calculated.

10. (Original) The image forming apparatus of claim 9, further comprising a storage device having a register and a memory, wherein the memory stores the data table beforehand, and

Application No. 10/692,267
Response to Office Action

Customer No. 01933

the register has a capacity storing three or more of either one
5 of an average value of detection information of both the roller
detection sensor and the ambient temperature sensor and an
average value of the surface temperature information.

11. (Original) The image forming apparatus of claim 9,
further comprising:

a difference calculator for calculating a difference between
detection information of the roller heat detecting sensor and
5 detection information of the ambient temperature detecting
sensor;

a comparing device for comparing an output value of the
difference calculator with a predetermined value; and

an abnormal detector for judging that the output value is
10 abnormal when the output value is greater than the predetermined
value.

12. (Original) A control method of an image forming
apparatus, comprising:

(a) calculating moving average values of detection
information obtained by a roller heat detecting sensor for
5 detecting heat radiated from a heating roller heated by a heating
element and of detection information obtained by an ambient

Application No. 10/692,267
Response to Office Action

Customer No. 01933

temperature detecting sensor for detecting an ambient temperature of the roller heat detecting sensor;

10 (b) calculating surface temperature information of the heating roller corresponding to both the calculated moving average values calculated from a data table in which the surface temperature information of the heating roller corresponding to the detection information of the roller heat detecting sensor and the detection information of the ambient temperature detecting
15 sensor is written;

(c) calculating the average value of the calculated surface temperature information to obtain a roller surface temperature; and

20 (d) comparing the obtained roller surface temperature with the fixing roller target temperature; and

(e) controlling a temperature of the heating roller on the basis of the comparison result.

13. (Original) An image forming apparatus comprising:

(a) a heating roller heated by a heating element;

(b) a roller heat detecting sensor for detecting heat radiated from the heating roller;

5 (c) an ambient temperature detecting sensor for detecting an ambient temperature of the roller heat detecting sensor;

Application No. 10/692,267
Response to Office Action

Customer No. 01933

(d) a surface temperature calculator for calculating surface temperature information of the heating roller;

10 (e) a heating controller for controlling the heating of the heating roller on the basis of the surface temperature information calculated by the surface temperature calculator;

15 (f) a difference calculator for calculating a difference between detection information of the roller heat detecting sensor and detection information of the ambient temperature detecting sensor,

wherein the surface temperature calculator calculates the surface temperature of the heating roller by making output information of the difference calculator and the detection information of the ambient temperature detecting sensor to be in
20 association with data table information in which the surface temperature information of the heating roller corresponding to the output information of the difference calculator and the detection information of the ambient temperature detecting sensor is written, and calculates an average value of the plural values
25 of the surface temperature information calculated.

14. (Original) The image forming apparatus of claim 13, further comprising a storage device having a register and a memory, wherein the memory stores the data table beforehand, and the register has a capacity storing three or more of either one

Application No. 10/692,267
Response to Office Action

Customer No. 01933

- 5 of an average value of detection information of both the roller detection sensor and the ambient temperature sensor and an average value of the surface temperature information.

15. (Original) The image forming apparatus of claim 13, further comprising:

- a difference calculator for calculating a difference between detection information of the roller heat detecting sensor and
5 detection information of the ambient temperature detecting sensor;

a comparing device for comparing an output value of the difference calculator with a predetermined value; and

- an abnormal detector for judging that the output value is
10 abnormal when the output value is greater than the predetermined value.

16. (Original) A control method of an image forming apparatus, comprising:

- (a) calculating a difference between output information obtained by a roller heat detecting sensor for detecting heat
5 radiated from a heating roller heated by a heating element and output information obtained by an ambient temperature detecting sensor for detecting an ambient temperature of the roller heat

Application No. 10/692,267
Response to Office Action

Customer No. 01933

detecting sensor through a difference calculator for calculating the difference;

10 (b) calculating a moving average value of the output information of the difference calculator and a moving average of the detection information of the ambient temperature detecting sensor;

15 (c) calculating surface temperature information of the heating roller corresponding to both the calculated moving average values from a data table in which the surface temperature information of the heating roller corresponding to the output information of the difference calculator and the detection information of the ambient temperature detecting sensor is
20 written;

(d) calculating an average value of the values of the calculated surface temperature information, thereby obtaining a roller surface temperature;

25 (e) comparing the obtained roller surface temperature with a fixing roller target temperature; and

(f) controlling a temperature of the heating roller on the basis of the comparison result.

17. (Original) An image forming apparatus comprising:

(a) a heating roller heated by a heating source;

Application No. 10/692,267
Response to Office Action

Customer No. 01933

(b) a detection sensor spaced apart from the heating roller sensor for detecting a surface temperature of the heating roller;

5 (c) a compensation sensor for detecting a temperature of the detection sensor;

(d) a storage device having an operation equation defined in correspondence with a region determined by the roller temperature range where normal printing is carried out;

10 (e) a calculator for calculating the surface temperature of the heating roller on the basis of detection outputs of the detection sensor and the compensation sensor using the operation equation; and

15 (f) a controller for controlling an application of an electric current to the heating source on the basis of the calculation result and a target control temperature.

18. (Original) An image forming apparatus comprising:

(a) a heating roller heated by a heating source;

(b) a detection sensor spaced apart from the heating roller for detecting a surface temperature of the heating roller,
5 wherein a roller temperature range in which a temperature of the heating roller is controlled, is undivided or divided into two or more temperature ranges;

(c) a compensation sensor for detecting the temperature of the detection sensor, wherein a detection output range of the

Application No. 10/692,267
Response to Office Action

Customer No. 01933

10 compensation sensor is undivided or divided into two or more
ranges;

(d) a storage device for storing respective operation
equations defined in accordance with regions determined by the
divided roller temperature ranges and the divided detection
15 ranges of the compensation sensor;

(e) a selector for selecting an operation equation
corresponding to one of the regions including a target control
temperature and the detection temperature of the compensation
sensor;

20 (f) a calculator for calculating the surface temperature of
the heating roller using the selected operation equation on the
basis of detection outputs of the detection sensor and the
compensation sensor; and

(g) a controller for controlling an application of an
25 electric current to the heating source on the basis of the
calculation result and the target control temperature.

19. (Original) An image forming apparatus comprising:

(a) a heating roller heated by a heating source;

(b) a detection sensor spaced apart from the heating roller
for detecting a surface temperature of the heating roller,

5 wherein a roller temperature range in which a temperature of the

Application No. 10/692,267
Response to Office Action

Customer No. 01933

heating roller is controlled, is divided into two or more
temperature ranges;

(c) a compensation sensor for detecting the temperature of
the detection sensor, wherein a detection output range of the
10 compensation sensor is undivided or divided into two or more
ranges;

(d) a storage device for storing respective operation
equations defined in accordance with regions determined by the
divided roller temperature ranges and the divided detection
15 ranges of the compensation sensor;

(e) a calculator for calculating the surface temperature of
the heating roller using the defined plural operation equations
on the basis of a detection output of the detection sensor and
the compensation sensor;

20 (f) a comparison judgment device for determining one having
a smaller value to be a final surface temperature out of the
plural calculation results; and

(g) a controller for controlling an application of an
electric current to the heating source on the basis of the final
25 surface temperature and a target control temperature.

20. (Original) The image forming apparatus of claim 18,
wherein any one of the divided roller temperature ranges is a

Application No. 10/692,267
Response to Office Action

Customer No. 01933

roller temperature range in which a normal printing is carried out.

21. (Original) The image forming apparatus of claim 17, wherein the operation equation is a linear operation equation.

22. (Original) The image forming apparatus of claim 18, wherein the detection output range of the compensation sensor is a detection output range of the compensation sensor in accordance with the temperature range of the detection sensor to control the temperature of the heating roller.

23. (Original) A control method of an image forming apparatus, comprising:

(a) reading a detection output of a detection sensor for detecting a temperature of a heating roller and a detection
5 output of a compensation sensor for detecting a temperature of the detection sensor;

(b) reading an operation equation stored beforehand for calculating a surface temperature of the heating roller set within a roller temperature range where normal printing is
10 carried out;

(c) calculating the operation equation in accordance with the detection output of the detection sensor and the compensation

Application No. 10/692,267
Response to Office Action

Customer No. 01933

sensor, whereby obtaining the surface temperature of the heating roller as a calculation result;

15 (d) comparing the obtained surface temperature with a target temperature; and

 (e) controlling the temperature of the heating roller on the basis of the comparison result.

24. (Original) A control method of an image forming apparatus, comprising:

 (a) reading a detection output of a detection sensor for detecting a temperature of a heating roller and a detection
5 output of a compensation sensor for detecting the temperature of the detection sensor;

 (b) reading a plurality of operation equations stored beforehand for calculating a surface temperature of the heating roller set within a temperature range where a temperature control
10 of the heating roller is to be carried out;

 (c) selecting an operation equation corresponding to a target control temperature and a detection value of the compensation sensor out of the read operation equations;

 (d) calculating the selected operation equation in
15 accordance with the detection output of the detection sensor and the detection output of the compensation sensor, whereby obtaining a surface temperature of the heating roller;

Application No. 10/692,267
Response to Office Action

Customer No. 01933

(e) comparing the obtained surface temperature with a target temperature; and

20 (f) controlling a temperature of the heating roller on the basis of the comparison result.

25. (Original) A control method of an image forming apparatus, Comprising:

(a) reading a detection output of a detection sensor for detecting a temperature of a heating roller and a detection
5 output of a compensation sensor for detecting a temperature of the detection sensor;

(b) reading a plurality of operation equations stored beforehand for calculating a surface temperature of the heating roller set within a temperature range where a temperature control
10 of the heating roller is to be carried out;

(c) selecting a plurality of operation equations corresponding to the detection values of the compensation sensor out of the read operation equations;

(d) calculating the selected operation equations in
15 accordance with the detection output of the detection sensor and the detection output of the compensation sensor, whereby obtaining a smallest one out of the calculation results as the surface temperature of the heating roller;

Application No. 10/692,267
Response to Office Action

Customer No. 01933

(e) comparing the obtained surface temperature with a target
20 temperature; and

(f) controlling the temperature of the heating roller on the
basis of the comparison result.

26. (Original) The control method of claim 23, wherein the
operation equation is a linear operation equation.

27. (Original) An abnormal temperature detecting device of
a fixing device of an image forming apparatus, for thermally
fixing a toner image formed on a transfer material by a heating
roller heated by a heating device, the abnormal temperature
5 detecting device comprising:

(a) a temperature detector having a first temperature sensor
for detecting a surface temperature of the heating roller and a
second temperature sensor for detecting an ambient temperature of
the first temperature sensor;

10 (b) a comparison device for comparing a detection signal
value of the first temperature sensor with a preset reference
value; and

(c) a judgment device for judging a temperature abnormality
of the heating roller or an abnormality of the first temperature
15 sensor on the basis of the comparison result.

Application No. 10/692,267
Response to Office Action

Customer No. 01933

28. (Original) The abnormal temperature detecting device of claim 27, wherein the judgment device judges that a detected temperature of the heating roller or the abnormality of the first temperature is abnormal in the case where a state that the
5 detection signal value of the first temperature sensor does not exceed the preset reference value lasts for a period of time not shorter than a preset reference time as the result of the comparison.

29. (Original) An abnormal temperature detecting device of a fixing device of an image forming apparatus for thermally fixing a toner image formed on a transfer material by a heating roller heated by a heating device, the abnormal temperature
5 detecting device comprising:

(a) a temperature detector having a first temperature sensor for detecting a surface temperature of the heating roller and a second temperature sensor for detecting an ambient temperature of the first temperature sensor;

10 (b) a differential amplification device for differentially amplifying a detection signal value of the first temperature sensor and a detection signal of the second temperature sensor to obtain a difference value; and

(c) a judgment device for judging that a detected
15 temperature of the surface temperature of the heating roller or

Application No. 10/692,267
Response to Office Action

Customer No. 01933

the ambient temperature of the first temperature sensor is abnormal in the case where a state that the difference value does not exceed a preset reference value lasts for a period of time not shorter than a preset reference time.

30. (Original) An abnormal temperature detecting device of a fixing device of an image forming apparatus for thermally fixing a toner image formed on a transfer material by a heating roller heated by a heating device, the abnormal temperature
5 detecting device comprising:

(a) a temperature detector having a first temperature sensor for detecting a surface temperature of the heating roller and a second temperature sensor for detecting an ambient temperature of the first temperature sensor;

10 (b) a differential amplification device for differentially amplifying a detection signal value of the first temperature sensor and a detection signal of the second temperature sensor to obtain a difference value; and

(c) a judgment device for judging that a detected
15 temperature of the temperature of the heating roller or the ambient temperature of the first temperature sensor is abnormal in the case where a state that the detection signal of the first temperature sensor does not exceed a first preset reference value lasts for a period of time not shorter than a first preset

Application No. 10/692,267
Response to Office Action

Customer No. 01933

20 reference time, in the case where a state that the detection
signal of the second temperature sensor does not exceed a second
preset reference value lasts for a period of time not shorter
than a second preset reference time, or in the case where a state
that the difference value does not exceed a third preset
25 reference value lasts for a period of time not shorter than a
third preset reference time.

31. (Original) The abnormal temperature detecting device of
claim 30, wherein t_1 , t_2 and t_3 are set so as to satisfy the
following inequality:

$$t_1 < t_2 < t_3$$

5 where t_1 represents the first reference time, t_2 represents the
second reference time, and t_3 represents the third reference
time.

32. (Original) An abnormal temperature detecting device of
a fixing device of an image forming apparatus for thermally
fixing a toner image formed on a transfer material by a heating
roller heated by a heating device, the abnormal temperature
5 detecting device comprising:

(a) a temperature detector having a first temperature sensor
for detecting a surface temperature of the heating roller and a

Application No. 10/692,267
Response to Office Action

Customer No. 01933

second temperature sensor for detecting an ambient temperature of the first temperature sensor;

10 (b) a differential amplification device for differentially amplifying a detection signal value of the first temperature sensor and a detection signal of the second temperature sensor to obtain a difference value; and

15 (c) a positive-and-negative source voltage supply device for supplying a positive source voltage and a negative source voltage for making an operation region of the differential amplification device to cover a range extending from a negative voltage to a positive voltage to the differential amplification device; and

20 (d) a judgment device for judging that a detected temperature of the temperature of the heating roller or the ambient temperature of the first temperature sensor is abnormal in the case where a signal polarity of the difference value is negative.

33. (Original) The abnormal temperature detecting device of claim 32, wherein the judgment device judges that the detected temperature of the temperature of the heating roller or the ambient temperature of the first temperature sensor is abnormal
5 in the case where a state that the signal polarity of the difference value is negative lasts for a period of time not shorter than a preset reference time.

Application No. 10/692,267
Response to Office Action

Customer No. 01933

34. (Original) The abnormal temperature detecting device of claim 27, further comprising a controller for controlling the heating device to stop once and to actuate later when the judgment device indicates an abnormality, and for judging the detected temperature of the temperature of the heating roller or the ambient temperature of the first temperature sensor to be abnormal when the judgment device judges again that the detected temperature is abnormal.

35. (Original) The abnormal temperature detecting device of claim 27, wherein the temperature detecting device further comprises a third temperature sensor placed at another position different from a placement position of the first temperature sensor, for detecting a surface temperature at the another position of the heating roller, and the abnormal temperature detecting device further comprising a confirmation device for confirming an abnormality on the basis of a detection signal value of the third temperature sensor and a third preset reference value.

36. (Original) The abnormal temperature detecting device of claim 35, further comprising a controller for controlling the heating device to stop once and to actuate later when the

Application No. 10/692,267
Response to Office Action

Customer No. 01933

5 judgment device indicates an abnormality, and for judging the
detected temperature of the temperature of the heating roller or
the ambient temperature of the first temperature sensor to be
abnormal when the judgment device judges again that the detected
temperature is abnormal.

37. (Original) The abnormal temperature detecting device of
claim 28, further comprising a switching device for changing a
length of the reference time set in the judgment device.

38. (Original) An image forming apparatus comprising the
abnormal temperature detecting device of the fixing device as set
forth in claim 27.